Results of forest insect and disease surveys in the EASTERN REGION of Ontario, 1991

CARRIED OUT BY THE GREAT LAKES FORESTRY CENTRE IN COOPERATION WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES

A. Keizer

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FORESTRY CANADA, ONTARIO REGION

Ontario Region is one of six regional establishments located across Canada and operated by Forestry Canada. The overall objective of Forestry Canada is to promote the preservation, enhancement and wise use of a healthy, attractive and bountiful forest resource and terrestrial environment for the economic and social benefit of all Canadians. Ontario Region pursues this objective by conducting two major programs: research and technical services and forestry development. Both programs address major problems affecting forest management and the forest environment primarily in Ontario, but because of the transprovincial nature of the forest resource, many elements of our research program are of national significance.

Ontario Region specializes in research in forest production, forest protection, forest environment and forest utilization. These programs deal directly with the issue of maintaining and enhancing the resource supply. Activities range from basic to applied and developmental research, and include a significant technology transfer component.

Major activities in forestry development include federal management responsibility for federal–provincial forest management agreements, participation in the National Forestry Statistics program and forest economics research.

Close working relationships are maintained with the Ontario Ministry of Natural Resources, the forest industry, educational institutions specializing in forestry and the biological sciences, and other forestry organizations within the province. Ontario Region is represented on the Ontario Forestry Council and the Ontario Forestry Research Committee, which have responsibility for coordinating forestry research in Ontario.

It is recognized that forested land must be managed in the best public interest, not only for the wood production essential to our economy, but also for the recreational purposes that are so important to our social well-being. This must be achieved in a manner that will maintain or improve the quality of the forest environment and preserve it for generations to come.

RESULTS OF FOREST INSECT AND DISEASE SURVEYS IN THE EASTERN REGION OF ONTARIO 1991

Forest Districts:
Napanee, Tweed, Carleton Place, Cornwall and Brockville

A. Keizer

FORESTRY CANADA
ONTARIO REGION
GREAT LAKES FORESTRY CENTRE

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SURVEY HIGHLIGHTS

This report describes surveys and estimates of forest damage as a result of insect, disease and abiotic causes in the Eastern Region of Ontario during 1991.

Cedar leafminer populations subsided throughout most of the region. Three years of severe defoliation contributed to pockets of top and/or whole-tree mortality first recorded during 1990 in the Brockville and Carleton Place districts. Re-evaluations in 1991 indicated that these areas were recovering.

Spruce budworm damage was first discovered in Gloucester Township, Carleton Place District, in 1990 and defoliation averaged 28% over 2 ha of white spruce trees. This year, the stand sustained 12% defoliation on the 13-m-tall trees. Forecasts are for high population levels again in 1992.

The larch casebearer increased its population levels and subsequent damage levels, with 16 stands affected in 1991. Defoliation estimates varied from 25 to 75% on the various hosts.

Damage by the fall webworm was elevated from 1990 levels, with numerous webmasses sighted throughout the region on single trees and small groups of hardwoods.

A 4% reduction in the area of moderate-to-severe defoliation caused by the gypsy moth occurred this year, with only 5,650 ha of scattered pockets recorded throughout the region. Egg-mass surveys performed by Forestry Canada, Ontario Region staff, again indicated that fewer areas are predicted to have high population levels in 1992.

A further 25% reduction in the area of forest tent caterpillar defoliation (to 329,023 ha) occurred as predicted, with reductions foreseeable again in 1992.

Jack pine sawfly and maple trumpet skeletonizer populations increased over 1990 levels at numerous locations throughout the region.

The maple leafcutter emerged at a couple of locations, causing severe foliar damage to sugar maple stands in Tweed District.

Aerial and ground surveys for Scleroderris canker once again failed to detect the presence of this disease in the region.

White pine blister rust evaluations in five plantations revealed branch and stem cankers on 1 to 21% of the trees.

Drought-like conditions prevailed during June, July and August through most of the region and caused a variety of foliar problems, particularly on hardwoods. The largest areas of drought damage were recorded at two locations in Carleton Place District.

Leaf scorch, anthracnose and leaf spot diseases were all observed at numerous locations throughout the region in 1991.

Maple health surveys continued with reassessments of plots established in woodlot, rural and urban situations. Current dieback estimates increased slightly on some of the urban and woodlot plot trees, but over all most trees remained relatively healthy.

The annual assessments of the North American Maple Project and Acid Rain National Early Warning System plots have both indicated very little change in the overall status of forest health in Eastern Region.

A slight decline occurred at both of the oak health plots in Carleton Place District; this may still represent the lingering effects of the drought experienced during the summer of 1988.

The cooperation and generous assistance supplied by the Ontario Ministry of Natural Resources (OMNR) from each of the five districts in the region is very much appreciated by Forestry Canada staff.

Alan J. Keizer

A newly discovered disease (*Entomophaga maimaiga* R.A. Humber, M. Shimazu & R.S. Soper) has been found causing gypsy moth larval mortality (top); resting spores of the fungus, magnified 800X (bottom).

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INSECTS

Major Insects

Cedar leafminer complex, *Argyresthia aureoargentella* Brower, *A. canadensis* Free., *A. thuiella* (Pack.), *Coleotechnites thujaella* (Kft.)

A substantial decrease in population levels and associated foliar damage on eastern white cedar (*Thuja occidentalis* L.) occurred throughout the region this season. Infestations have persisted since 1988 and have contributed to top and/or whole-tree mortality that was first recorded in 1990 in the Brockville and Carleton Place districts.

All that remained of the infestations during 1991 were light levels of defoliation scattered through Oxford on Rideau and Augusta townships of Brockville District. Defoliation estimates ranged from 0 to 21% through these areas. At the G. Howard Ferguson Forest Station in Kemptville, mature windbreak trees averaged 21% defoliation. Successive years of defoliation have again warranted foliar protection with two applications of the systemic insecticide Cygon® 2E by OMNR staff at the station. Single applications were applied in May and August in an effort to suppress leafminer populations.

Eastern spruce budworm, *Choristoneura fumiferana* (Clem.)

Provincial Situation

In Ontario, a total of 9,065,781 ha of balsam fir (*Abies balsamea* [L.] Mill.) and spruce (*Picea* spp.) sustained moderate-to-severe defoliation during 1991, expanding the 6,783,261 ha defoliated during 1990 by 2,282,520 ha. These increases occurred primarily in the North Central, Northeastern and Northern regions (Fig. 1).

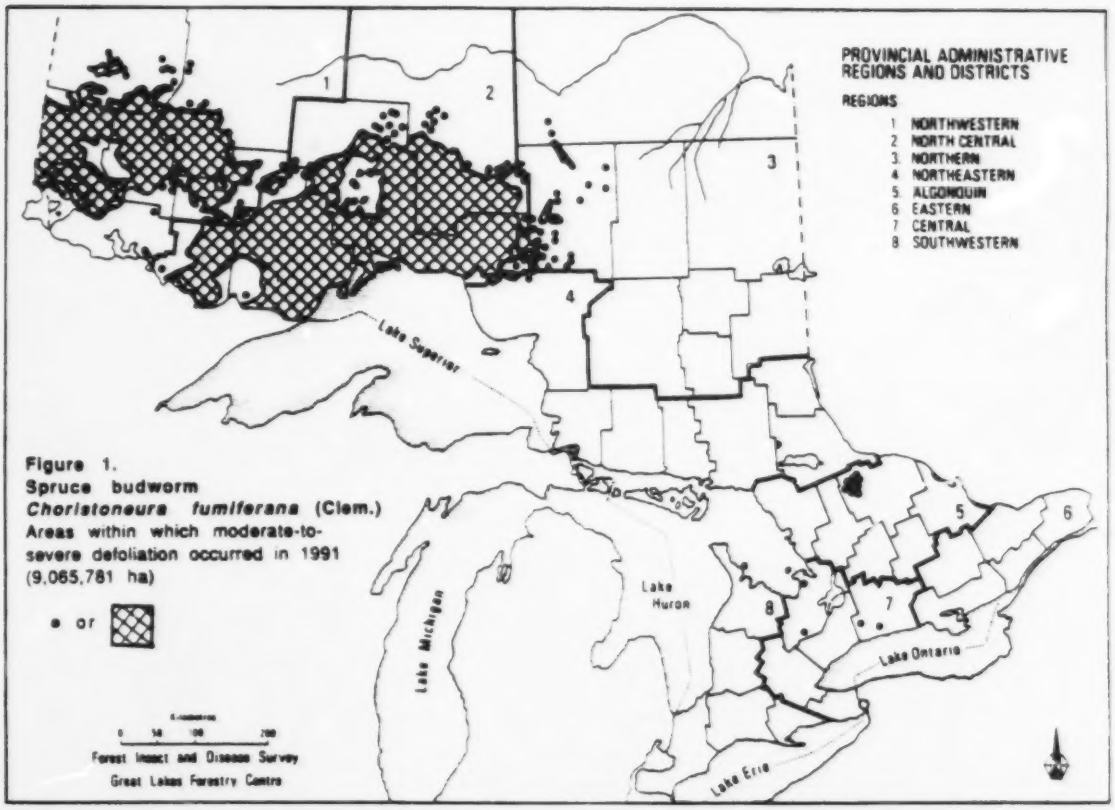

Figure 1.
Spruce budworm *Choristoneura fumiferana* (Clem.)
Areas within which moderate-to-severe defoliation occurred in 1991 (9,065,781 ha)

The biological insecticide B.t. (*Bacillus thuringiensis* Berliner) was applied by OMNR in single or double applications over 65,000 ha of budworm-damaged stands. This occurred in late May and early June in the North Central and Northern regions.

Eastern Region

A small stand of white spruce (*Picea glauca* [Moench] Voss) located on Davidson Road in Gloucester Township, Carleton Place District, was again defoliated during 1991. Defoliation in the 2-ha plantation of 13-m-tall trees averaged 12%. Egg-mass samples used to predict future populations indicate that higher population levels will occur at this site in 1992.

Larch Casebearer,
Coleophora laricella (Hbn.)

This introduced European insect has again increased its numbers and subsequent foliar damage to tamarack (*Larix laricina* [Du Roi] K. Koch), Japanese larch (*Larix leptolepis* [Sieb. & Zucc.] Gord.) and European larch (*Larix decidua* Mill.) throughout the region during 1991.

Sixteen affected areas ranging from 0.25 to 25 ha were detected aerially or from the ground throughout the region. Estimates of defoliation levels ranged from 25 to 75%. The largest area was a 25-ha tamarack stand north of Smith Falls in Montague Township, Carleton Place District. This stand also contained the highest level of defoliation (75%). Only one generation of this insect occurs per year; however, damage in a single season is often attributed to feeding by two generations of larvae.

Fall Webworm,
Hyphantria cunea (Drury)

Large numbers of webs were observed throughout the region on single and small groups of hardwoods, with ash (*Fraxinus* spp.) the most common host. Complete defoliation of host trees of all sizes was not uncommon, especially in lowland and open-field situations. As many as 30 webs per tree were observed, particularly in lowland areas along the Highway 16 and 401 corridors in Brockville District and in scattered areas along Highway 7, particularly in eastern Carleton Place District.

Gypsy Moth,
Lymantria dispar (L.)

The regional total of moderate-to-severe defoliation during 1991 declined from 5,883 ha to 5,650 ha in 1991 (a 4% reduction), comprising mainly scattered pockets of damage (Fig. 2, 3). This area represents only 1.6% of the 347,415 ha of moderate-to-severe defoliation present in Ontario during 1991. The Algonquin and Central regions of Ontario sustained the majority of this defoliation (337,936 ha, 97% of the 347,415-ha provincial total)[1], primarily to hardwoods. The majority of defoliation in Eastern Region (76%) occurred in Napanee District, with 4,285 ha of scattered pockets ranging from 10 to 590 ha in size (Tables 1 and 2). These areas were located primarily in Adolphustown, Tyendinaga, Thurlow, Sidney and Fredericksburg townships of Hastings County, and in Bedford and Loughborough townships of Frontenac County (Fig. 2).

Tweed District contained 19% of the regional defoliation, with 1,085 ha of small pockets ranging from 20 to 485 ha in size. These areas were primarily concentrated in the Marmora, Lake, Grimsthorpe and Hungerford townships of Hastings County, and as far north as Abinger Township in Lennox and Addington County.

Brockville District forests were relatively free of extensive defoliation again this year, with only a single pocket of moderate-to-severe defoliation (85 ha) near the town of Westport in North Crosby Township.

Carleton Place District contained 105 ha of forests infested with gypsy moth scattered among three areas ranging from 30 to 45 ha in size. These were recorded in South Sherbrooke and Dalhousie townships of Lanark County.

[1] Jones, C.G. and Bolan, P.M. 1992. Results of forest insect and disease surveys in the Algonquin Region of Ontario, 1991. For. Can., Ont. Region, Sault Ste. Marie, Ont. Misc. Rep. 117. 32 p.

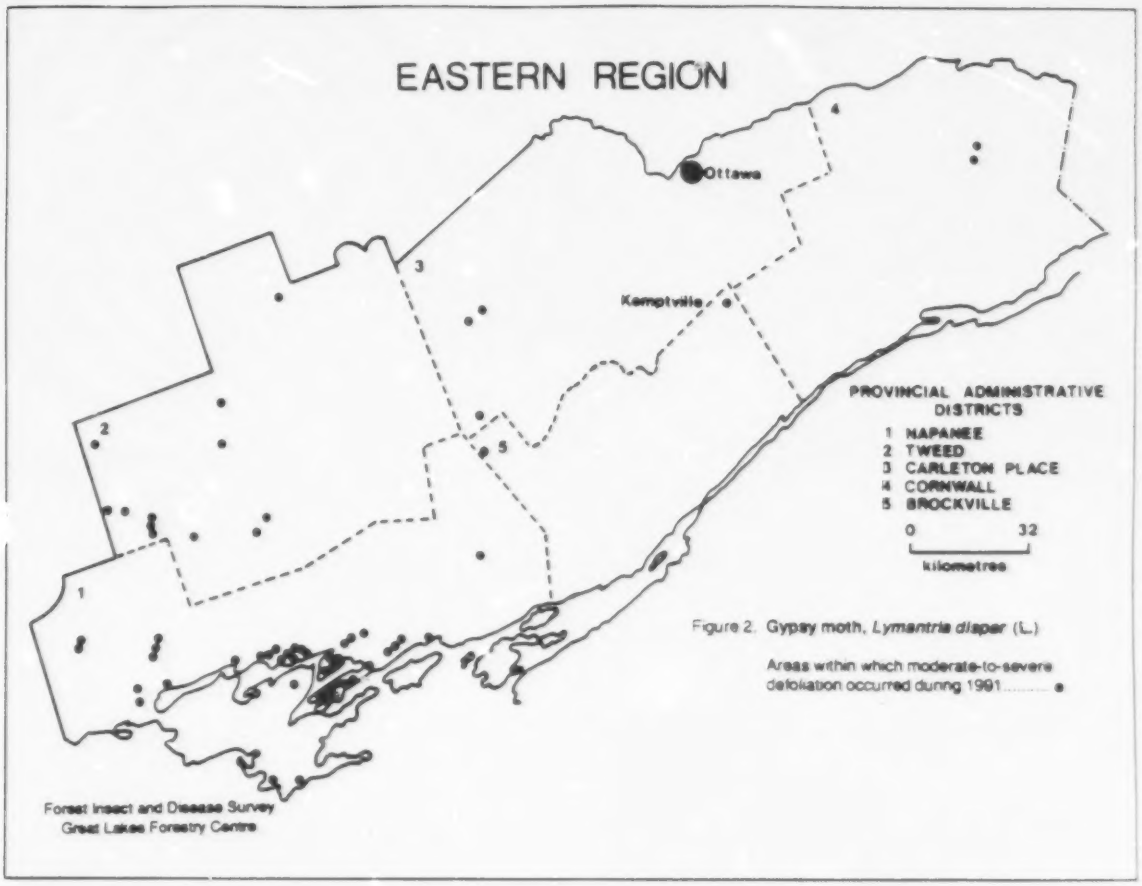

Figure 2. Gypsy moth, *Lymantria dispar* (L.)

Table 1. Gross area of moderate-to-severe hardwood defoliation by the gypsy moth in the Eastern Region of Ontario during 1990 and 1991 (by district).

District	Gross area (ha) 1990	1991	Change %	Area (ha)
Napanee	4,086	4,285	+5	+199
Tweed	1,259	1,085	-14	-174
Brockville	395	85	-78	-310
Carleton Place	143	105	-26	-38
Cornwall	0	90	+100	+90
	5,883	5,650		

Egg-mass surveys performed by Forestry Canada, Ontario Region, (FCOR) staff during August and September indicate that infestations may recur at moderate-to-severe levels at both Sharbot Lake (Oso Township, Tweed District) and Frontenac provincial parks (Loughborough Township, Napanee District).

Table 2. Gross area of moderate-to-severe hardwood defoliation by the gypsy moth in the Eastern Region of Ontario during 1990 and 1991, by county.

County	Area (ha) 1990	1991
Hastings	806	2,740
Lennox and Addington	905	2,625
Northumberland	607	665
Frontenac	3,234	225
Prince Edward	74	140
Lanark	143	105
Leeds and Grenville	395	85
Glengarry	0	60
Prescott	0	30

The gypsy moth larval burlap and pheromone trapping programs were virtually discontinued in 1990 as the primary means of initial detection in southern Ontario. A smaller experimental program

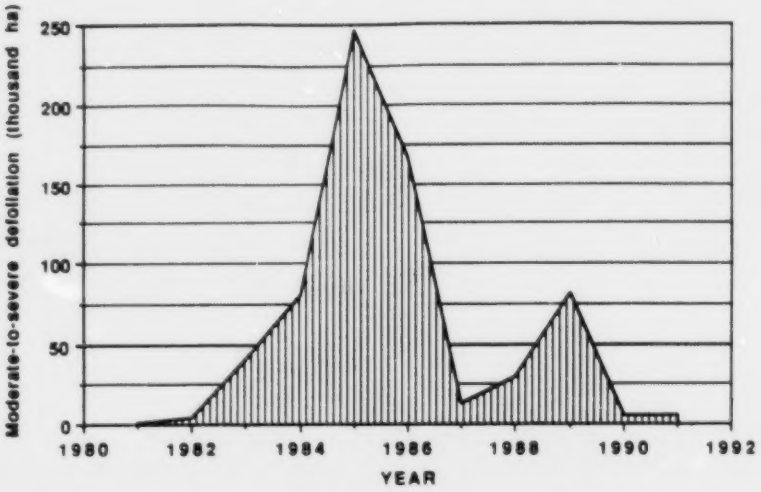

Figure 3. Area of moderate-to-severe defoliation by the gypsy moth (*Lymantria dispar* [L.]) in the Eastern Region of Ontario from 1981 to 1991.

is continuing, primarily in Eastern Region, to test various traps and pheromone concentrations. In this region, 13 parks are still being trapped and the results are presented in Table 3. Three nonsaturating Multi–pher® pheromone traps were deployed at each park this year in lieu of the former two nonsaturating Deltoid® traps. Low-concentration pheromones supplied by G. Grant of Forestry Canada's Forest Pest Management Institute were used as bait. The average number of adult males captured in pheromone traps in each park (three per park) during 1991 was 297. The larval burlap trapping program (10 traps per location) revealed slightly higher catches than in 1990, with the largest numbers reported from Sharbot Lake, Fitzroy, Lake-on-the-Mountain and Bon Echo provincial parks.

The gypsy moth fungus *Entomophaga maimaga* Humber, Shimazu & Soper was recovered for the first time in Ontario from dead larvae sampled near Sandbanks Provincial Park, Napanee District (see Frontispiece) in 1990. This entomopathogenic fungus has reportedly caused extensive epizootics in outbreak populations of the gypsy moth in the northeastern United States. Concentrated surveys carried out during the larval period in an effort to isolate additional pathogens identified four other sites at which *Entomophaga* was found in 1991. To date, the following locations have produced infected larvae:

- Sandbanks Provincial Park, Hallowell Township, Napanee District
- At the North American Maple Project site 3.2 km north of location 1.
- Two km east of Adolphustown, Adolphustown Township, Napanee District.
- West of Adolphustown (approximately 0.5 km).
- Sharbot Lake Provincial Park, Oso Township, Tweed District.

Actual "mounds" of dead larvae were abundant at the bases of infested trees at each of the above sites, particularly at the Adolphustown locations. Isolates of a nuclear polyhedrosis virus (NPV) and a parasitic fungus (*Paecilomyces* spp.) also contributed to larval mortality.

Host Impact

Twenty-six randomly selected plots were established through the Tweed and Napanee districts during 1982, soon after gypsy moth populations became a problem in 1981. These plots comprise 387 trees and 13 different species, and assessments include estimates of defoliation, dieback, mortality and growth. A partial summary of information from unpublished studies in these plots by D.B. Roden (Forestry Canada, Ontario Region, Sault Ste. Marie, Ont.) is given in Table 4. Defoliation estimates for 1988 are unavailable because of technical discrepancies; thus, mortality for 1988 has been included in the 1989 data. Increasing mortality is quite noticeable beginning in 1988/1989. This increase is a probable reflection of the drought experienced during 1988 and successive years of severe defoliation by both the forest tent caterpillar and the gypsy moth.

Table 3. A summary of the results of gypsy moth burlap and pheromone trapping and defoliation estimates at 13 parks in the Eastern Region of Ontario during 1991.

Location (Provincial Park)	Burlap traps (10 per location) Total number of larvae 1990	1991	Pheromone traps Number of male moths captured 1990[a]	1991[b]	Average defoliation Hosts	%	Number of egg masses[c]
Brockville District							
Charleston Lake	719	794	67	1,076	sM, rO, tA, wB	5	10
Carleton Place District							
Fitzroy	3,157	4,577	53	359	rO, sM, tA, siM	5	11
Murphy's Point	723	858	1,253	943	rO, tA, wB, sM	10	7
Rideau River	17	–[f]	44	353	siM, tA, wB	2	3
Silver Lake	264	626	36	3,211	rO, sM, tA, wB	10	7
Cornwall District							
Carillon	0	4	43	44	wB, sM	2	4
Jessup's Falls Conserv. Area	612	172	36	273	rO, tA, wB	2	2
Napanee District							
Frontenac	584	399	1,451	1,856	rO, tA, wB	50[d]	16
Lake-on-the-Mountain	1,655	917	48	934	sM, siM	5	4
Presquile	257	50	71	82	rO, sM	5	4
Sandbanks	30	217	90	739	rO, wB, tA, sM	5	6
Tweed District							
Bon Echo	310	966	44	1,170	rO, tA, sM	5	8
Sharbot Lake	3,018	2,312	1,381[e]	546	rO, sM, tA, wB	10	22

[a] USDA Deltoid, saturating type; two per location
[b] Multi-Pher, nonsaturating type; three per location
[c] average number, based upon "5 minute walk" method
[d] includes forest tent caterpillar defoliation
[e] Multi-Pher-2 traps with G. Grant lures; three per location; catches not included with averaged numbers
[f] data unavailable

Aerial Spraying for Gypsy Moth Suppression

An aerial spray program was again utilized by OMNR over approximately 34,000 ha of high-value forests. Each spray block received double applications of the bacterial pesticide B.t. (30 BIU/ha per application) between mid-May and mid-June.

In Eastern Region, approximately 11,616 ha were sprayed in Lanark County and in the Brockville and Tweed districts. Of this area, approximately 1,974 ha were Crown lands and 9,642 ha private lands.

Forest Tent Caterpillar, *Malacosoma disstria* Hbn.

A slight decline in the area of moderate-to-severe defoliation has occurred once again this year, an indication that the natural controlling factors (i.e., parasites, diseases, climate, etc.) have begun the declining trend typical of this insect's infestation cycle. Over all, there was a 0.4% reduction in the area of moderate-to-severe hardwood defoliation, from 330,307 ha in 1990 to 329,023 ha in 1991 (Fig. 4).

Tweed District contained the largest area of insect-damaged hardwoods, with 215,633 ha (66% of the regional total) (Table 5). An eastward movement of this infestation has occurred again, causing decreased defoliation in Napanee District and substantial increases in the Brockville, Carleton Place and Cornwall districts. Some portions of Tweed District have been defoliated for four (Tudor, Grimsthorpe, Anglesea, Barrie, Elzevir and Kala-

Table 4. Defoliation and mortality in gypsy moth impact plots established in 1982 and monitored from 1982 to 1991 in the Eastern Region of Ontario.

Tree species	Total number of trees	Number of dead trees when plot established	Number of dead trees									Average defoliation									Total number dead	% total dead
			1982	1983	1984	1985	1986	1987	1989[a]	1990	1991	1982	1983	1984	1985	1986	1987	1989	1990	1991[b]	1982–1991	
Red oak (*Quercus rubra* L.)	195	10	0	0	3	1	2	5	26	15	15	30	25	12	75	25	27	98	39	66	67	34
White oak (*Q. alba* L.)	69	0	0	0	0	1	1	0	2	3	1	41	34	18	57	17	22	97	21	71	8	12
Red maple (*Acer rubrum* L.)	73	2	0	1	2	1	2	2	6	3	0	5	7	5	38	1	7	21	10	6	17	23
Sugar maple (*A. saccharum* Marsh.)	8	0	0	0	0	0	0	0	0	0	0	4	1	0	3	1	5	10	5	6	0	0
White ash (*Fraxinus americana* L.)	10	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	30	13	29	0	0
White birch (*Betula papyrifera* Marsh.)	9	0	0	0	1	0	0	3	0	1	0	1	3	35	33	1	4	15	5	5	5	44
Ironwood (*Ostrya virginiana* [Mill.] K. Koch)	13	0	0	0	0	0	0	0	1	0	0	15	4	3	1	1	1	17	6	5	1	8
Others[c]	10	0	0	0	1	1	0	1	1	0	0	7	9	16	39	1	3	18	5	9	4	40

[a] includes 1988 mortality

[b] defoliation caused primarily by *M. disstria* Hbn.

[c] trembling aspen (*Populus tremuloides* Michx.), eastern white pine (*Pinus strobus* L.), white elm (*Ulmus americana* L.), butternut (*Juglans cinerea* L.), shagbark hickory (*Carya ovata* [Mill.] K. Koch), black cherry (*Prunus serotina* Ehrh.)

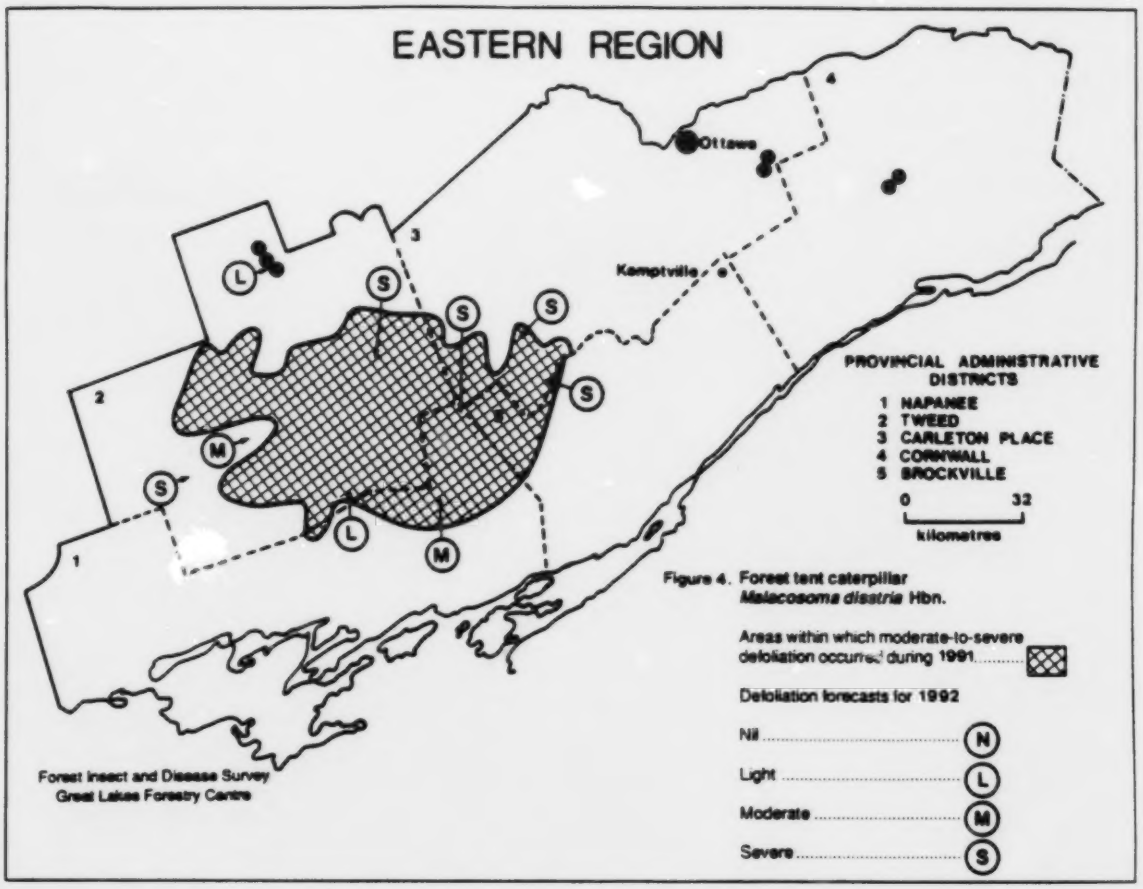

Figure 4. Forest tent caterpillar *Malacosoma disstria* Hbn.

dar townships) and five (Kaladar and Elzevir townships) consecutive years. The following townships sustained moderate-to-severe levels of defoliation and were a major part of the large pocket present in the region: Tudor, Grimsthorpe, Anglesea, Barrie, Clarendon, Palmerston, Kennebec, Olden, Oso, Sheffield, Hungerford and Hinchinbrooke. Additional smaller pockets of damage were located in Denbigh and Abinger townships.

The area of moderate-to-severe defoliation in Napanee District decreased by 18% (14,211 ha), from 78,479 ha in 1990 to 64,268 ha in 1991. This area shifted from the northwestern portion of the district to newer infestations in the southern portion of the district. This area includes Portland, Loughborough, and Camden townships. Smaller defoliated stands were also recorded in Storrington and South Crosby townships.

Table 5. Gross area of moderate-to-severe defoliation caused by the forest tent caterpillar in the Eastern Region of Ontario during 1990 and 1991.

	Area of moderate-to-severe defoliation (ha)	
District	1990	1991
Tweed	215,441	215,633
Napanee	78,479	64,268
Carleton Place	14,367	24,336
Brockville	22,020	23,548
Cornwall	0	1,238
Total	330,307	329,023

Additional new areas of defoliation appeared this year in Brockville District over 1,520 ha. This easternmost edge of the main pocket of hardwood defoliation spread into North Crosby, South Crosby and South Burgess townships.

The area of hardwood defoliation in Carleton Place District increased from 14,367 ha in 1990 to the present 24,336 ha. Extensions to the east occurred in North Burgess, Bathurst, North Elmsley and Osgoode townships. Smaller affected stands were also observed in Osgoode, Cumberland and Cambridge townships.

Forest tent caterpillar population levels for 1992 were forecast using egg-band counts taken in the previous fall and have been compared with host type, host diameter and the number of trees sampled (Table 6). The estimates for 1992 indicate a re-infestation of approximately the same area infested during 1991, with slight border fluctuations to the east in the Carleton Place and Brockville districts (Fig. 4). A continuing decline in the total area affected is probably imminent over the next couple of years in response to natural controlling factors. Higher levels of larval mortality were evident throughout the infestation this year. Actual pockets of dead larvae, induced by viral, bacterial and fungal (particularly *Furia crustosa* [Macleod & Tyrrel]) agents, were a common sight.

Jack Pine Sawfly,
Neodiprion pratti paradoxicus Ross

Increasing numbers of defoliated jack pine (*Pinus banksiana* Lamb.) and Scots pine (*Pinus sylvestris* L.) trees have again prompted numerous control inquiries by various landowners. Most instances concerned open-grown trees, ornamental trees, hedgerows or plantations. Visual defoliation estimates ranged from 2 to 90%. Evaluations of seven jack pine plantations revealed that the average defoliation ranged from 5 to 75% (Table 7).

Many private landowners initiated control by following specific application instructions supplied with all available *contact* insecticides.

Minor Insects

Maple Trumpet Skeletonizer,
Epinotia aceriella (Clem.)

Since 1987 moderate-to-severe damage levels caused by this insect have been present on regeneration and lower crowns of mature sugar maple (*Acer saccharum* Marsh.) over approximately 25 ha of Presquile Provincial Park. Located in Hallowell Township, Napanee District, this area has again sustained high levels of defoliation, with an average of 50% crown defoliation over 80% of the 21-m trees. Sugar maple regeneration sustained even higher levels of defoliation, averaging 90% on 90% of the trees. However, fewer observations of pest damage were noted than in 1990 through the region. One other sugar maple stand (60% sugar maple composition), in Sandbanks Provincial Park, was observed with an average of 25% defoliation on 30% of the mature trees.

Table 6. Forest tent caterpillar egg-band samples collected from trembling aspen and sugar maple in three districts of the Eastern Region of Ontario during 1991, with infestation forecasts for 1992.

District Township	Host	Average DBH (cm)	Average number of egg bands per tree	Infestation forecast for 1992
Carleton Place District				
Bathurst	tA	5	15	Severe
North Burgess	tA	10	10	Severe
Napanee District				
Bedford	sM	12	13	Severe
Loughborough	tA	4	5	Moderate
Tweed District				
Abinger	tA	16	1	Light
Elzevir	tA	6	16	Severe
Kaladar	tA	4	6	Severe
Olden	tA	4	8	Severe
Sheffield	tA	6	1	Light

Maple Leafcutter,
Paraclemensia acerifoliella (Fitch)

Approximately 10 ha of mature sugar maple located near the town of Ompah in Palmerston Township, Tweed District, were severely defoliated in 1991, with 100% of the trees averaging 80% foliar browning. Similar damage was noted on Shawenegog Lake in Barrie Township over approximately 5 ha. Low levels of this leafminer were commonly observed inflicting light foliar damage throughout the region. Elevated levels of this insect have not been evident in the region since 1988.

Table 7. Damage by the jack pine sawfly in seven jack pine plantations in the Eastern Region of Ontario in 1991 (evaluations based upon an examination of 150 trees).

Location (Twp)	Average height of trees (m)	Estimated trees per ha	Estimated area affected (ha)	Trees affected (%)	Average defoliation (%)
Brockville District					
Augusta	5	100	1	100	75
Augusta	2	1,100	2	25	25
Elizabethtown	3	1,000	4	30	25
Elizabethtown	3	1,200	2	40	60
Carleton Place District					
Lanark	15	50	1	100	30
Montague	5	1,000	2	30	20
Napanee District					
Ernestown	3	1,000	2	2	5

Table 8. Other forest insects.

Insect	Host(s)	Remarks
Chionaspis pinifoliae (Fitch) Pine needle scale	muP	Two 2-m trees contained large numbers of scale insects over 50% of their foliage in Fitzroy Provincial Park, Carleton Place District.
Choristoneura p. pinus Free. Jack pine budworm	jP	Approximately 20 mature hedgerow trees sustained 20% defoliation north of the town of Hopetown in Carleton Place District.
Corthylus punctatissimus (Zimm.) Pitted ambrosia beetle	sM	Approximately 0.25 ha of maple regeneration (an estimated 200 stems) sustained girdling damage by this beetle at the Acid Rain National Early Warning System (ARNEWS) site in Rear of Yonge and Escott Township in Brockville District.
Corythuca ulmi O.& D. Elm lace bug	wE	Feeding (sucking) by this insect caused entire host crowns to appear chlorotic. All sizes of trees were affected and damage could be seen scattered throughout the region.
Corythuca sp. prob. *arcuata* (Say) Oak lace bug	wO	Single trees were observed frequently throughout the region with 50 to 100% yellow foliage.
Corythuca sp. prob. *juglandis* (Fitch) Lace bug	Ba	This insect caused 90% foliar discoloration on scattered individuals throughout the region.

(cont'd)

Table 8. Other forest insects (concl.).

Insect	Host(s)	Remarks
Elaphidionoides parallelus (Newm.) Hickory twig pruner	rO	Lower incidence levels occurred this year, with only single trees observed with light damage (<10%) in Charleston Lake Provincial Park.
Epinotia timidella (Clem.) Oak trumpet skeletonizer	wO	Single trees of all sizes through the area of Clayton Road in Ramsay Township, Carleton Place District, averaged 30% defoliation.
Leucoma salicis (L.) Satin moth	siPo	Increasing numbers of this pest defoliated single trees along Hwy 401 in Brighton Township, Napanee District, and in the towns of Perth, Kemptville and Winchester. Defoliation levels ranged from 50 to 80%.
Malacosoma americanum (F.) Eastern tent caterpillar	*Prunus* spp. *Malus* spp.	There were frequent sightings of single trees with multiple webs and as high as 100% defoliation. Levels of this caterpillar have increased from previous years.
Neodiprion abietis complex Balsam fir sawfly	bF	Elevated numbers caused upper-crown defoliation of single trees and small groups of trees of all sizes throughout the host's range. The largest numbers and associated defoliation were encountered in small stands in Fitzroy and Osgoode twps in Carleton Place District and in Effingham Twp of Tweed District.
Neodiprion sertifer (Geoff.) European pine sawfly	jP, ScP	A 2-ha plantation of 2.7-m jack pine in Ernestown Twp, Napanee District, and a 1-ha plantation of 1.9-m jack pine in Mountain Twp, Cornwall District, averaged 5 and 2% defoliation, respectively. A 1-ha Scots pine plantation averaging 3 m in height sustained 20% average defoliation in Oxford on Rideau Twp, Brockville District.
Pineus strobi (Htg.) Pine bark adelgid	wP	A 1.0-ha plantation of 10-m trees in Fitzroy Prov. Park, Carleton Place District, contained six trees hosting this insect, with 60% of the main stems affected. The Taylor Lake clonal seed orchard in Lanark Twp, Carleton Place District, contained this insect on 45% of the 0.8-m trees in a 5-ha area. Control was initiated by OMNR staff. Four additional plantations assessed, ranging from 1.5 to 3 m in height, also contained this insect on 2 to 28% of the trees at low levels.
Rhynchaenus rufipes (LeC.) Willow flea weevil, and *Plagiodera versicolora* (Laich.) Imported willow leaf beetle	W	Severe foliar browning induced by these leaf-feeding beetles was again most apparent near Collins Bay in Kingston, at the mouth of the Trent River at Trenton, and in Silver Lake and Sharbot Lake provincial parks, as well as at scattered locations throughout the region.
Symmerista canicosta Franc. Redhumped oakworm	rO	Total defoliation of understory regeneration (up to approx. 5 m) occurred over 0.25 ha on Salmon Lake in Frontenac Provincial Park.
Taeniothrips inconsequens (Uzel) Pear thrips	sM	This introduced pest again induced foliar damage on regeneration trees up to 5 m in height. The North American Maple Project plot in Hallowell Township, Napanee District, sustained severe foliar deformities on approximately 2% of the regeneration in a 2-ha area.
Zelleria haimbachi Bsk. Pine needle sheathminer	jP	A 2-ha plantation of 2.7-m trees averaged 20% defoliation over 90% of the trees in Lot 22 in Ernestown Twp, Napanee District.

TREE DISEASES

Major Diseases

Scleroderris Canker,
Gremmeniella abietina (Lagerb.) Morelet

Aerial and ground surveys once again failed to detect the presence of this disease of pine and spruce in the region during 1991. Particular interest was paid to plantations in northern Tweed District adjacent to active infections by the European race in Mayo Township, Bancroft District. Twenty plantations throughout the region were surveyed from the ground (500 trees evaluated per site), and both ground and aerial surveys will be continued in 1992.

White Pine Blister Rust,
Cronartium ribicola J.C. Fischer

Four of five plantations specifically evaluated for blister rust infections (Table 9), had below-average infection levels in an area considered to have a moderate hazard rating[2]. In Edwardsburgh Township, Brockville District, a progeny test for blister rust resistance sustained a 21% infection level among the untended trees; 12% of these had stem cankers and 3% were dead.

Anthracnose,
Apiognomonia tiliae (Rehm) Höhnel on *Tilia americana* L., *Apiognomonia errabunda* (Roberge.) Höhnel on *Acer saccharum* Marsh.,
and
Leaf Spot Diseases,
Septoria negundinis Ell. & Ev. on *Acer* spp., *Mycosphaerella effigurata* (Schwein.) House on *Fraxinus* spp., and *M. populicola* G.E. Thompson on *Populus balsamifera* L.

All the above diseases were found in conjunction with drought and leaf scorch, causing widespread foliar browning at numerous locations. The most severe levels of infections were entire stands of ash ranging in area from 0.5 to 2.0 ha, with 90 to 100% foliar browning, particularly in Tyendinaga, Kingston and Ernestown townships of Napanee District. In conjunction with the drought/leaf scorch damage (see the section on Abiotic Damage in this report), foliar damage was evident in practically every stand throughout the region. Spring temperatures and humidity levels favored the development and spread of these diseases.

[2]Gross, H.L. 1985. White pine blister rust: a discussion of the disease and hazard zones for Ontario. White Pine Symposium. Suppl. Proc. ent. Soc. Ont. 116: 73–79.

Table 9. Summary of blister rust evaluations in five eastern white pine plantations in the Eastern Region of Ontario during 1991 (evaluations based upon an examination of 150 trees per location).

Location Township	Average height of trees (m)	Estimated trees per ha	Estimated area affected (ha)	Trees affected (%)	Trees severely affected (%)	Trees dead (%)
Brockville District						
Augusta	2	800	4	0	0	0
Edwardsburgh	2	600	1	21	12	3
Front of Escott	1.2	550	2	0	0	0
Lanark	0.9	300	5	1	1	0
Carleton Place District						
Darling	1.8	500	2	1	1	0

Table 10. Other forest diseases.

Organism	Host(s)	Remarks
Gymnosporangium clavipes (Cooke & Peck) Quince rust	ErCe	Increasing levels of tree infections were evident on scattered individuals throughout the region.
Cryptococcus fagisuga Linding. Beech scale, and *Nectria galligena* Bres. Nectria canker	Be	Ten percent of the trees in Presquile Prov. Pk. were affected for the third consecutive year by this insect. The small stand of maple and beech at the Gananoque Golf Course was also reinfested, with 2% of the stems affected. *Nectria galligena* was recovered at this site (from a single tree) for the first time since monitoring began 4 years ago.
Phomopsis juniperovora Hahn Phomopsis blight	WrCe	Severe browning of natural stands occurred in Cramahae and Murray townships, Napanee District. Damage was limited to the upper 50% of crowns.
Porcupine damage	rP	A 0.5-ha plantation of 3-m trees sustained 3.3% mortality and 5.6% of the trees in Front of Escott Township near LaRue Mills, Brockville District, were affected.
Sphaeropsis sapinea (Fr.) Dyko & B. Sutton Diplodia tip blight	muP	New infections were observed in Tweed District at two locations in Abinger Twp, where 10% of fifty 2-m roadside trees and 1% of a 1-ha stand of 5-m trees were 50 and 10% affected, respectively. In Denbigh Twp, 4% of 25 roadside trees were 25% affected.

ABIOTIC DAMAGE

Drought and Leaf Scorch

Below-normal rainfall was recorded at both the Ottawa and the Trenton airports for the months of June through September 1991 (Table 16). Total precipitation was well below normal (73.4 mm) in June, with only 14 mm recorded at the Ottawa station and 22 mm at the Trenton station (where 63.7 mm is normal). Temperatures, on the other hand, were above normal at both stations from June through August. This combination of anomalies and above-normal rainfall in early spring coupled with above-normal temperatures, induced a variety of foliar problems. The wet, warm spring provided ideal conditions for the rapid spread of some foliar diseases while the higher temperatures also caused premature leaf discoloration and leaf fall. Actual drought damage on small hardwoods was aerially recorded as early as mid-July on thin-soiled hillsides and hill crests over approximately 290 ha in southern Pakenham Township and over 51 ha on the western side of the Carp Ridge in March Township, both in Carleton Place District (Fig. 5). Leaf anthracnose diseases, leaf spots and leaf scorch also contributed to much of the damage, as levels of these problems were severe at many points throughout the region. These sightings were so numerous that the entire region was depicted as sustaining damage. Leaf scorch is caused by periods of severe, dry winds that dessicate the foliage at times when soil moisture is so low that root absorption is minimal. Unable to obtain sufficient moisture, the leaves quickly turn brown and necrotic, usually along the margins of the leaves first.

A reassessment of two impact plots established during 1990 in an area of mortality induced by drought and insects is presented in Table 11. The impact plot inside the area of mortality has remained relatively unchanged. The control plot, located outside the area of mortality, has shown a continued decline. Many of the trees assessed in the lowest dieback class (0–5%) have progressed into the next two higher dieback classes (6–20%, 21–40%), indicating that a state of decline persists. This is evident in both current and cumulative estimates.

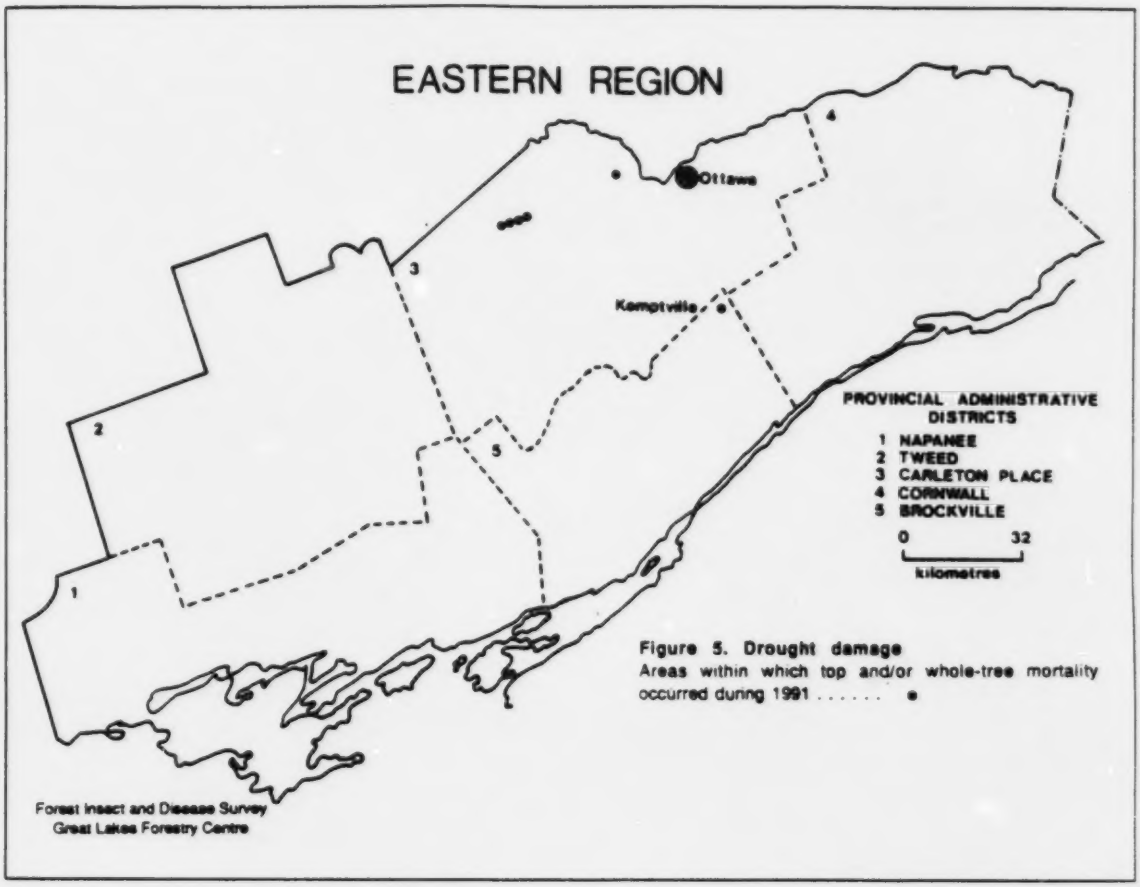

Figure 5. Drought damage
Areas within which top and/or whole-tree mortality occurred during 1991 . . . . . •

FOREST HEALTH

Acid Rain National Early Warning System – ARNEWS

A rising concern for Canadian forests has been stirred since the early 1980s, when alarming levels of tree decline, supposedly due to air pollutants, were being reported from other parts of the world. In 1984, ARNEWS plots were established nationally by Forestry Canada to detect early signs of damage. Three of these plots are located in Eastern Region: in eastern white pine in Hungerford Township, Tweed District; in white spruce in Gloucester Township, Carleton Place District; and in sugar maple in Rear of Yonge and Escott Township, Brockville District. Annual assessments have revealed no definite signs of acidification-related damage. For the second consecutive season, the 13-m white spruce at the Gloucester Township plot sustained light defoliation by the spruce budworm. Average defoliation was 12% on 80% of the trees. Egg-mass sampling to predict future population levels indicates a reinfestation of the stand in 1992.

Maple Health

Woodlots and Forest Stands

Ten 25-tree sugar maple plots established during 1987 in woodlot situations have been reassessed to determine levels of crown dieback and defect. The 1991 assessments revealed a further decline in the condition of current growth: many trees in the 0–5% class (Class 0) have progressed into the 6–20% class (Class 1) of dieback beginning in 1989 (Table 12). The overall percentage of trees in Class 1 has increased from 38% in 1990 to 45% in 1991. Blowdown has killed two additional

Table 11. Data from two plots established within an area of hardwood mortality (Impact Plot 1) and an adjacent area (Control Plot 1) during 1990 and 1991 in Tudor Township, Tweed District (plots consist of 25 trees).

	Tree species	Number of trees	Average DBH (cm)	Average height (m)	Basal area (m^2/ha)	Number of trees with crown dieback, by dieback class[a]											
						Current						Cumulative					
						0	1	2	3	4	5	0	1	2	3	4	5
Impact Plot 1																	
1990	rO	17	20.4	11.3	21.7	0	1	0	0	0	16	0	1	0	0	0	16
	wP	6	14.6	6.7	5.0	6	0	0	0	0	0	6	0	0	0	0	0
	sM	1	9.5	7.0	0	0	1	0	0	0	0	0	1	0	0	0	0
	rM	1	8.0	6.9	0	1	0	0	0	0	0	1	0	0	0	0	0
1991	rO					0	1	0	0	0	16	0	1	0	0	0	16
	wP					6	0	0	0	0	0	6	0	0	0	0	0
	sM					0	1	0	0	0	0	0	1	0	0	0	0
	rM					1	0	0	0	0	0	0	1	0	0	0	0
Control Plot 1																	
1990	rO	18	23.0	16.8	16.7	4	14	0	0	0	0	0	10	7	1	0	0
	rM	4	11.3	12.5	3.3	3	1	0	0	0	0	3	0	1	0	0	0
	He	2	12.2	5.5	3.8	2	0	0	0	0	0	2	0	0	0	0	0
	wP	1	46.8	18.0	0	0	1	0	0	0	0	0	1	0	0	0	0
1991	rO					0	8	9	0	0	0	0	6	11	1	0	0
	rM					3	1	0	0	0	0	3	0	1	0	0	0
	He					2	0	0	0	0	0	2	0	0	0	0	0
	wP					0	1	0	0	0	0	0	1	0	0	0	0

[a] Dieback classification: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, 5 = dead

trees in the Rear of Leeds and Lansdowne Township plot, Brockville District. Wood-decay fungi in overmature trees were contributing factors to additional mortality at the Rear of Yonge and Escott Township plot in Brockville District, where a single tree was later cut and removed, and at two of the Brighton Township plots in Napanee District, where seven trees were removed. Estimates of insect damage were generally light (<20% average defoliation) at four of 10 plots, with the principle defoliator being the maple trumpet skeletonizer at three Brighton Township plots. The Rear of Yonge and Escott Township plot in Brockville District was the only one that contained forest tent caterpillar defoliation this year, with an average of 5% damage throughout the plot (Fig. 6).

Urban and Rural

Five 25-tree sugar maple plots at both urban (i.e., city parks, city streets, city shade trees, etc.) and rural (i.e., roadsides, windrows, driveways, right-of-ways, etc.) locations were reassessed for the third year in 1991 (Table 13).

The urban plots (Fig. 6) have revealed similar current decline estimates to the plots in woodlot situations (Table 13). An increase in the number of trees in dieback classes 1 and 2 was significant, and approximately 65% of the trees had 6 to 20% current branch mortality. An increase was also apparent in dieback class 3; nearly 6% of the trees had 21 to 40% current branch mortality. Three additional trees died from unknown causes. Insect defoliation occurred at trace levels, and low levels of leaf scorch were apparent in two of the five plots.

Table 12. Maple health data from 10 plots established in woodlots and forest stands in 1987 to monitor sugar maple health in the Eastern Region of Ontario (data based on an examination of 25 host trees per location).

Location	Average DBH	Average height	Estimated stand area		Number of trees, by crown dieback class[a]											
					Current						Cumulative					
(Twp)	(cm)	(m)	(ha)	Year	0	1	2	3	4	5	0	1	2	3	4	5
Brockville District																
Oxford on Rideau	35.6	24	15	1987	21	4	0	0	0	0	12	13	0	0	0	0
				1988	25	0	0	0	0	0	9	16	0	0	0	0
				1989	25	0	0	0	0	0	5	20	0	0	0	0
				1990	21	4	0	0	0	0	2	23	0	0	0	0
				1991	13	12	0	0	0	0	11	14	0	0	0	0
Rear of Leeds and Lansdowne	66.4	28	2	1987	21	4	0	0	0	0	16	8	1	0	0	0
				1988	18	7	0	0	0	0	12	12	1	0	0	0
				1989	20	2	0	0	0	3[b]	0	20	2	0	0	3[b]
				1990	17	3	0	0	0	2[b]	2	18	0	0	0	5[b]
				1991	15	3	0	0	0	2[b]	13	5	0	0	0	7[b]
Rear of Yonge and Escott	33.6	21	30	1987	23	2	0	0	0	0	18	7	0	0	0	0
				1988	25	0	0	0	0	0	14	11	0	0	0	0
				1989	23	2	0	0	0	0	4	21	0	0	0	0
				1990	20	5	0	0	0	0	9	13	0	3	0	0
				1991	11	13	0	0	0	1[c]	9	15	0	0	0	1[c]
Carleton Place District																
Nepean	37.1	20	4	1987	23	2	0	0	0	0	23	2	0	0	0	0
				1988	21	3	0	0	0	1	20	4	1	0	0	1
				1989	22	2	0	0	0	1	8	16	0	0	0	1
				1990	13	11	0	0	0	1	1	23	0	0	0	1
				1991	17	7	0	0	0	0	12	12	0	0	0	1[d]

(cont'd)

Table 12. Maple health data from 10 plots established in woodlots and forest stands in 1987 to monitor sugar maple health in the Eastern Region of Ontario (data based on an examination of 25 host trees per location) (concl.).

Location (Twp)	Average DBH (cm)	Average height (m)	Estimated stand area (ha)	Year	Number of trees, by crown dieback class[a] Current 0	1	2	3	4	5	Cumulative 0	1	2	3	4	5
Carleton Place District (concl.)																
Lavant	37.6	22	20	1987	19	6	0	0	0	0	16	8	1	0	0	0
				1988	16	9	0	0	0	0	12	13	0	0	0	0
				1989	25	0	0	0	0	0	0	23	2	0	0	0
				1990	17	8	0	0	0	0	1	22	2	0	0	0
				1991	15	9	1	0	0	0	11	13	1	0	0	0
Pakenham	50.5	25	15	1987	22	3	0	0	0	0	12	11	2	0	0	0
				1988	20	5	0	0	0	0	4	19	2	0	0	0
				1989	21	4	0	0	0	0	1	22	2	0	0	0
				1990	5	19	1	0	0	0	0	18	6	1	0	0
				1991	3	21	1	0	0	0	0	24	1	0	0	0
Napanee District																
Brighton, Staff House	53.9	23.2	1	1987	23	2	0	0	0	0	14	11	0	0	0	0
				1988	23	2	0	0	0	0	10	14	1	0	0	0
				1989	23	2	0	0	0	0	5	20	0	0	0	0
				1990	7	17	0	0	0	1[d]	5	18	0	0	0	1
				1991	12	12	0	1	0	0	5	17	1	1	0	1[d]
Brighton, Camp site	45.2	24.2	1	1987	24	1	0	0	0	0	20	4	1	0	0	0
				1988	21	4	0	0	0	0	3	22	0	0	0	0
				1989	25	0	0	0	0	0	3	22	0	0	0	0
				1990	15	10	0	0	0	0	3	22	0	0	0	0
				1991	8	12	1	0	0	4[c,e]	3	15	2	1	0	4[c,e]
Brighton, Entrance	54.2	22.5	2	1987	25	0	0	0	0	0	23	2	0	0	0	0
				1988	21	4	0	0	0	0	12	13	0	0	0	0
				1989	19	6	0	0	0	0	3	22	0	0	0	0
				1990	15	9	0	0	0	1[d]	6	16	2	0	0	1[d]
				1991	13	9	0	0	0	3[c]	11	10	0	0	0	4[c,d]
Cramahe	32.3	21.9	2	1987	25	0	0	0	0	0	24	1	0	0	0	0
				1988	25	0	0	0	0	0	14	11	0	0	0	0
				1989	25	0	0	0	0	0	12	13	0	0	0	0
				1990	17	8	0	0	0	0	7	17	1	0	0	0
				1991	17	8	0	0	0	0	13	11	1	0	0	0
% of total trees (n = 250)				1987	90	10	0	0	0	0	71	27	2	0	0	0
				1988	85	14	0	0	0	1	43	54	0	0	0	1
				1989	91	7	0	0	0	2	16	80	2	0	0	2
				1990	59	38	1	0	0	2	15	76	4	2	1	2
				1991	53	45	1	1	1	4	38	59	3	1	0	8

[a] dieback classification: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, 5 = dead
[b] blowdown
[c] decay/heartrot
[d] unknown cause
[e] trees felled

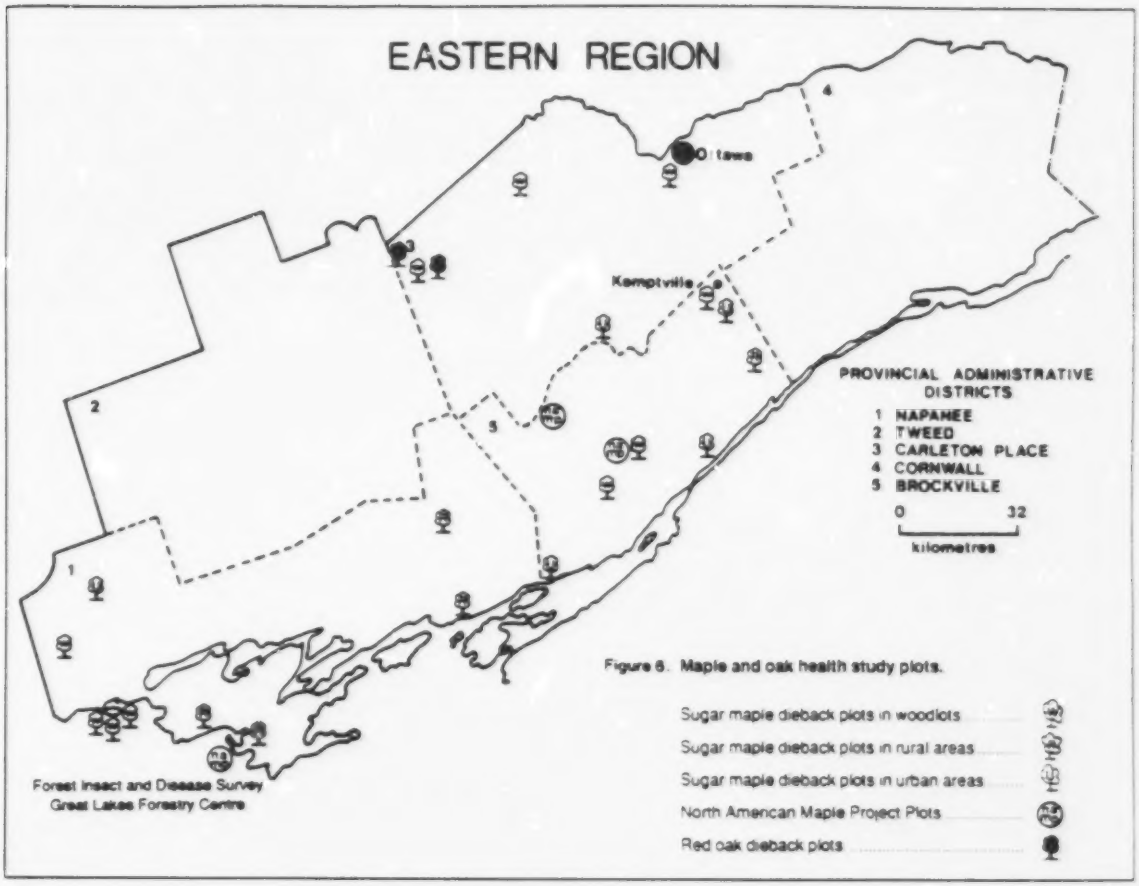

Figure 6. Maple and oak health study plots.

The rural plots also contained levels of current branch mortality similar to those in woodlot and urban plots. An estimated 70% of the trees were in dieback class 1. These plots contained the highest overall levels of current and cumulative branch mortality (Table 13). Mortality was evident in three of the five plots in 1991. Six trees died as an apparent result of old age and associated wood-decay fungi. Four of these trees were in the Hillier Township plot in Napanee District.

When overall estimates (rural and urban) are calculated from all 250 trees, a slight yearly increase in dieback is observed in the 6-20% dieback class (Class 1): current branch dieback totaled 53.6% in 1990 and 67.2% in 1991. Cumulative estimates also show a similar increase, with 62% of the trees in Class 1 in 1990 and 68% in 1991. New mortality (4% over all) was slightly higher this year.

North American Maple Project (NAMP)

Numerous plots have been established and assessed annually since 1988 throughout four Canadian provinces and seven American states as part of the North American Maple Project. The primary objectives of this project are to: (1) determine the rate of change in sugar maple tree condition ratings from 1988 through 1993; (2) determine if the rate of change in these ratings differs with respect to levels of pollution (measured as wet deposition), between sugarbush and undisturbed forest, and with respect to various levels of initial stand decline; and (3) determine the possible causes of sugar maple decline and the geographical relationship between causes and the extent of decline.

Table 13. Maple health data from 10 plots each established in rural and urban locations during 1989 in the Eastern Region of Ontario (data based on an examination of 25 sugar maple trees per location).

Location (Twp)	Plot type	Average DBH (cm)	Average height (m)	Year	Number of trees, by crown dieback class[a] Current 0	1	2	3	4	5	Cumulative 0	1	2	3	4	5
Brockville District																
Elizabethtown	Urban	64	23	1989	17	8	0	0	0	0	6	19	0	0	0	0
				1990	13	12	0	0	0	0	4	18	3	0	0	0
				1991	10	12	3	0	0	0	7	15	3	0	0	0
Front of Leeds and Lansdowne	Urban	59	24	1989	11	13	1	0	0	0	3	19	3	0	0	0
				1990	12	12	1	0	0	0	7	12	6	0	0	0
				1991	4	20	1	0	0	0	3	21	1	0	0	0
Oxford on Rideau	Urban	55	19	1989	19	4	2	0	0	0	6	15	3	0	1	0
				1990	11	14	0	0	0	0	3	17	5	0	0	0
				1991	3	20	1	0	0	1[c]	2	20	2	0	0	1[c]
Carleton Place District																
North Elmsley	Urban	68	22	1989	17	8	0	0	0	0	1	21	3	0	0	0
				1990	13	11	1	0	0	0	10	13	2	0	0	0
				1991	10	12	1	0	0	2[c]	9	13	1	0	0	2[c]
Napanee District																
Seymour	Urban	68	21	1989	9	14	2	0	0	0	1	20	4	0	0	0
				1990	0	19	1	0	0	5[c]	0	12	7	1	0	5[c]
				1991	1	17	1	0	0	1[d]	0	16	3	0	0	6[c,d]
Average		63	22													
% of trees (n=125)	Urban			1989	58.4	37.6	4.0	0.0	0.0	0.0	13.6	75.2	10.4	0	0.8	0.0
				1990	39.2	54.4	2.4	0.0	0.0	4.0	19.2	57.6	18.4	0.8	0.0	4.0
				1991	22.4	64.8	5.6	0.0	0.0	3.2	16.8	68.0	8.0	0.0	0.0	7.2

(cont'd)

Table 13. Maple health data from 10 plots each established in rural and urban locations during 1989 in the Eastern Region of Ontario (data based on an examination of 25 sugar maple trees per location) (concl.).

Location (Twp)	Plot type	Average DBH (cm)	Average height (m)	Year	Number of trees, by crown dieback class[a] — Current 0	1	2	3	4	5	Cumulative 0	1	2	3	4	5
Brockville District																
Edwardsburgh[b]	Rural	47	21	1990	15	10	0	0	0	0	7	14	4	0	0	0
				1991	8	17	0	0	0	0	8	17	0	0	0	0
Napanee District																
Hallowell	Rural	59	26	1989	4	17	4	0	0	0	1	14	10	0	0	0
				1990	9	12	4	0	0	0	1	15	8	1	0	0
				1991	3	20	1	0	0	1[c]	1	17	6	0	0	1[c]
Hillier	Rural	67	19	1989	6	13	5	1	0	0	3	11	7	2	2	0
				1990	5	15	2	1	2	0	1	18	2	0	4	0
				1991	2	14	3	1	1	4[c]	1	12	5	1	2	4[c]
Kingston	Rural	53	23	1989	14	10	1	0	0	0	11	13	1	0	0	0
				1990	10	13	2	0	0	0	6	17	2	0	0	0
				1991	3	19	2	0	0	1[c]	3	19	2	0	0	1[c]
Loughborough	Rural	70	22	1989	13	9	3	0	0	0	1	18	5	1	0	0
				1990	7	16	2	0	0	0	0	19	5	1	0	0
				1991	4	17	4	0	0	0	1	20	4	0	0	0
Average		59	22													
% of trees (n=125)	Rural			1989	37.0	49.0	13.0	1.0	0.0	0.0	16.0	56.0	23.0	3.0	2.0	0.0
				1990	36.8	52.8	8.0	0.8	1.6	0.0	12.0	66.4	16.8	1.6	3.2	0.0
				1991	16.0	69.6	8.0	0.8	1.6	4.8	11.2	68.0	13.6	0.8	1.6	4.8
% of total trees (n=250)	Rural and Urban			1989	52.4	39.6	7.6	0.4	0.0	0.0	18.0	66.0	14.0	1.0	1.0	0.0
				1990	38.0	53.6	5.2	0.4	0.8	2.0	15.6	62.0	17.6	1.2	1.6	2.0
				1991	19.2	67.2	6.8	0.4	0.8	4.0	14.0	68.0	10.8	0.4	0.8	6.0

[a] Dieback classification: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, 5 = dead
[b] established in 1990
[c] trees felled
[d] unknown cause

Table 14. Crown conditions of sugar maple assessed annually since 1988 at three North American Maple Project plots in the Eastern Region of Ontario.

Location (Twp)	Year	Average DBH (cm)	Number of trees examined	Total percentage of dead crown (Number) 0	1–5	6–15	16–25	26–35	36–45	46–55	56–65	66–75	76–85	86–95	96–100	Trees dead	Number of trees blown down or felled
Brockville District																	
South Burgess[b]	1988	38.4	42	0	31	7	2	2	0	0	0	0	0	0	0	0	0
	1989		42	0	14	22	5	1	0	0	0	0	0	0	0	0	0
	1990		42	0	31	8	3	0	0	0	0	0	0	0	0	0	0
	1991		42	0	37	3	2	0	0	0	0	0	0	0	0	0	0
Yonge and Escott[a]	1988	19.1	60	0	44	16	0	0	0	0	0	0	0	0	0	0	0
	1989		60	0	49	11	0	0	0	0	0	0	0	0	0	0	0
	1990		60	0	53	7	0	0	0	0	0	0	0	0	0	0	0
	1991		60	0	44	14	1	0	0	0	0	0	0	0	0	1	0
Napanee District																	
Hallowell[a]	1988	33.0	30	0	15	14	1	0	0	0	0	0	0	0	0	0	0
	1989		30	0	17	11	2	0	0	0	0	0	0	0	0	0	0
	1990		30	0	17	12	1	0	0	0	0	0	0	0	0	0	0
	1991		30	0	20	9	1	0	0	0	0	0	0	0	0	0	0
% total trees	1988			0	68.2	28.0	2.3	2.3	0	0	0	0	0	0	0	0	0
(n=132)	1989			0	60.6	33.3	5.3	0.8	0	0	0	0	0	0	0	0	0
	1990			0	76.5	19.7	3.0	0	0	0	0	0	0	0	0	0	0
	1991			0	76.5	19.7	3.0	0	0	0	0	0	0	0	0	0	0

[a] undisturbed woodlot

[b] trees currently tapped for maple sap

Three plots were established in the Napanee and Brockville districts of Eastern Region (Table 14). These plots contained a total of 132 sugar maple trees, of which more than 90% were reassessed and found to contain less than 15% dieback. Yearly fluctuations in dieback levels have remained minimal. Statistical analyses of differences between managed sugar bush plots and undisturbed woodlot plots are impractical with data from only three plots. Analysis of all data is being performed annually and will be available in a separate report.

Oak Health

Annual surveys of branch dieback at two plots in Lavant Township of Carleton Place District have again revealed a decline in the health of these oak stands (Table 15). Both plots are on thin soils that lie on or between sloping areas of exposed shield bedrock, and may still be experiencing the effects of the 1988 drought (Fig. 6).

Estimates from both plots indicate an overall increase in branch mortality in the 21–40% dieback class (Class 2). Over all, 46% of the trees are now in this class, an 18% increase since 1990. This apparent decline has been occurring since 1988.

Mortality increased slightly, with three new deaths in plot 2 and one in plot 1. No visible signs of causal organisms were evident on or around the dead trees. The overall average cumulative mortality since 1984 at both plots (183 trees, 93 in plot 1 and 90 in plot 2) is 9%.

Climatic Data

Temperature and precipitation play an important role in the development of insect, disease and abiotic damage. For this reason, data on these two parameters has been compiled for 1991 in Table 16.

Table 15. Data collected from from 1984 to 1991 at two red oak plots established in the Carleton Place District of the Eastern Region of Ontario (based on an examination of 93 trees in Plot 1 and 90 trees in Plot 2).

Location	Average DBH of trees (cm)	Stand size (ha)	Year	Current dieback class[a] (Number of trees)						Cumulative dieback class[a] (Number of trees)					
				0	1	2	3	4	5	0	1	2	3	4	5
Carleton Place District															
Lavant Twp – Plot 1	26.3	40.0	1984	10	51	20	6	6	0	0	26	47	15	5	0
			1985	36	35	14	7	1	0	0	26	47	15	5	0
	26.5		1986	43	35	11	1	0	3[b]	0	30	42	12	6	3
			1987	56	31	2	0	0	1[b]	3	40	32	11	3	4
			1988	51	36	1	1	0	0	6	56	23	4	0	4
			1989	28	58	1	1	0	1	2	49	26	11	0	5
			1990	4	76	2	0	3	3	0	42	38	2	3	8
			1991	2	27	49	1	0	1	0	26	56	1	1	9
Lavant Twp – Plot 2 Flower Station	21.4	15.0	1984	19	48	18	3	2	0	–	19	49	19	3	0
			1985	48	37	3	0	2	0	0	31	47	11	1	0
	21.9		1986	42	39	8	0	0	1[b]	0	39	44	4	2	1
			1987	66	20	3	0	0	0	6	51	25	3	4	1
			1988	63	26	0	0	0	0	7	58	22	1	1	1
			1989	27	59	1	0	0	2	1	70	11	5	0	3
			1990	48	34	1	0	2	2	2	75	5	1	2	5
			1991	6	55	15	5	1	3	4	44	28	3	3	8
% total trees (n=183)			1991							2	38	46	2	2	9

[a] 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, 5 = dead

[b] blowdown

Table 16. A comparison of 1991 mean temperatures and total precipitation with their normal values (based on a 30-year period) from two locations in the Eastern Region of Ontario.

Location	Month	Mean temperature (°C)		Deviation from normal (°C)	Total precipitation (mm)		Deviation from normal (mm)
		Normal	Actual		Normal	Actual	
Ottawa	Jan.	-10.9	-10.6	+0.3	61.0	51.4	-9.6
International	Feb.	-9.5	-6.1	+3.4	60.3	45.7	-14.6
Airport	Mar.	-3.0	-1.3	+1.7	67.5	87.1	+19.6
	Apr.	5.6	8.3	+2.7	69.1	130.6	+61.5
	May	12.8	15.6	+2.8	67.9	71.5	+3.6
	June	18.0	19.9	+1.9	73.4	14.0	-59.4
	July	20.6	21.6	+1.0	85.9	49.1	-36.8
	Aug.	19.2	20.9	+1.7	88.4	63.6	-24.8
	Sept.	14.3	13.2	-1.1	79.3	61.4	-17.9
	Oct.	8.1	9.1	+1.0	68.1	92.6	+24.5
	Nov.	1.2	1.6	+0.4	77.7	40.7	-37.0
	Dec.	-7.7	-7.7	0.0	80.7	70.0	-10.7
Trenton	Jan.	-7.6	-1.8	+5.8	68.9	46.3	-22.6
Air Base	Feb.	-6.5	-4.9	+1.6	57.0	25.5	-31.5
	Mar.	-1.0	-0.1	+0.9	72.0	110.2	+38.2
	Apr.	6.4	7.3	+0.9	76.1	90.3	+14.2
	May	12.5	11.0	-1.5	73.0	60.0	-13.0
	June	17.8	17.7	-0.1	63.7	22.1	-41.6
	July	20.6	20.3	-0.3	60.9	51.8	-9.1
	Aug.	19.7	20.0	+0.3	71.9	75.4	-3.5
	Sept.	15.3	14.2	-1.1	72.8	72.2	-0.6
	Oct.	9.2	8.5	-0.7	70.1	78.0	+7.9
	Nov.	3.2	2.2	-0.1	86.1	60.6	-25.5
	Dec.	-4.5	-4.6	-0.1	82.9	69.4	-13.3